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HIV Seroprevalence, Associated Risk Behavior, and Alcohol Use Among Male Rwanda Defense Forces Military Personnel

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Abstract A cross-sectional study was conducted among active-duty male soldiers, aged ≥21 years, in the Rwanda Defense Forces (RDF) and included an anonymous behavioral survey and HIV rapid testing to determine risk factors associated with HIV seroprevalence. Overall prevalence was 2.6 % (95 % CI: 1.84–3.66); personnel who were divorced, separated or widowed, served ≥6 years, never deployed, uncircumcised, reported STI symptoms, had ≥6 lifetime sex partners, or screened positive for harmful alcohol use (via Alcohol Use Disorders Identification Test) had higher HIV prevalence. Ever being divorced, separated or widowed (OR = 29.8; 95 % CI: 5.5–159.9), and STI symptoms (OR = 3.4; 95 % CI: 1.5–7.6) were significantly associated with infection, after multivariable adjustment, while circumcision was protective (OR = 0.4; 95 % CI: 0.2–0.9). Despite mobility and other factors that uniquely influence HIV transmission in militaries, RDF prevalence was similar to the general population. A reason for this finding may be conservative sexual behavior combined with effective leadership-supported prevention programs. Data suggest a concentrated rather than generalized epidemic, with targets identified for intervention.

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Resumen Se realizó un estudio transversal en soldados de género masculino en servicio activo, mayores de 21 años de edad, en las Fuerzas de Defensa de Ruanda (RDF, por sus siglas en inglés), y se incluyó una encuesta anónima sobre comportamiento y pruebas rápidas de VIH para determinar los factores de riesgo asociados con la seroprevalencia de VIH. La sero-prevalencia global fue de 2.6 % (IC al 95 % 1.84–3.66); el personal divorciado, separado o viudo, que hayan servido más de seis años, que nunca hayan sido enviados a zonas alejadas, no circuncidados, que hayan reportado síntomas de ITS, que hayan tenido más de 6 compañeros sexuales en toda su vida, o que hayan resultado positivos en el tamizaje de problemas de alcoholismo (en base a la Prueba de Identificación de Trastornos Debidos al Uso de Alcohol) mostraron una prevalencia de VIH mas alta. El haber sido divorciado/separado/viudo (OR = 29.8; 95 % CI: 5.5–159.9), y el haber tenido sintomas de ITS (OR = 3.4; 95 % CI: 1.5–7.6) fueron factores asociados significativamente con la infección por VIH luego de haber ajustado por las demás variables, mientras que la circuncisión resultó tener un efecto protector (OR = 0.4; 95 % CI: 0.2–0.9). A pesar de

la movilidad y otros factores que afectan de manera única la transmisión de VIH en militares, la prevalencia de VIH en RDF fue similar a la población general. Una razón que explique este hallazgo puede ser el comportamiento sexual conservador combinado con los programas efectivos de prevención basada en apoyo de los grupos líderes. Los datos sugieren una epidemia concentrada, más que generalizada, con objetivos identificados para intervenciones.

Keywords HIV · Rwanda · Military · Sexual risk behavior · Alcohol

Introduction

HIV seroprevalence, associated risk behavior and alcohol use is rarely assessed in African military populations and never before reported in the Rwanda Defense Forces (RDF). The general population of Rwanda has a lower HIV prevalence (3 % among those aged 15–49 years) [1] than many countries in sub-Saharan Africa, with a decrease in seroprevalence from a decade ago [2, 3]; data suggest conservative sexual behavior may be one reason for this observation. Lower prevalence populations are an essential part of surveillance not only to identify behaviors that may contribute to lower rates, but importantly, to identify high risk behavior or other factors that could escalate the prevalence if ignored.

The HIV epidemic within the Rwandan general population is well characterized, but HIV infection within militaries may be influenced by factors or circumstances that are rare or absent among civilians (e.g., rank, living away from family, deployments, attitude changes needed to survive and succeed during combat). Therefore, it is important to characterize and evaluate their HIV epidemic separately using instruments which allow for comparison to the civilian population.

Contrary to the predominant belief that military populations constitute a higher risk group [4–6], HIV prevalence is not always higher in military populations than civilians [7–9]. Militaries may attract individuals with lower prevalence (e.g., male, younger age, residing in low prevalence regions) [9] and in militaries that have changed their HIV testing policies, initial prevalence among recruits may be negligible in militaries that screen for HIV upon recruitment, and enlist only those who screen negative. Once in the military, HIV prevalence could presumably remain low if military leadership supports combination HIV prevention through advantageous structural, behavioral and clinical mechanisms not available in the civilian community. For example, if free medical care is highly integrated into the military structure, access to circumcisions may be easier among military personnel than among men of comparable age in the civilian population. Also, routinely scheduled physical exams could lead to prompt identification and treatment of sexually transmitted infections (STI). Intensive HIV prevention education that encourages reducing the number of sexual partners and providing widely available, free or low cost condoms to military personnel may also reduce transmission. In many militaries, frequent HIV testing is not only promoted as part of a volunteer-basis "Know Your Status" messaging campaign, but may also be required before and after deployments. If HIV infection is identified earlier with these mechanisms in place and soldiers are subsequently provided with seamless follow-through care from point of testing to treatment provision, transmission to other sexual partners could also be reduced.

Before identifying suitable population targets and methods of intervention to reduce HIV infection, population-specific risks must be identified, and the type of epidemic (generalized, concentrated or mixed) must be determined [10]. This study sought to characterize the contemporary HIV epidemiology among RDF personnel, identify what factors are associated with infection and determine whether seroprevalence was comparable to civilians. In order to maximize representativeness of the data, RDF military personnel were recruited at sites throughout Rwanda (including border regions, and urban and rural sites) to complete a standardized risk behavior survey linked to HIV rapid tests which included questions on military relevant factors suggested to be associated with HIV, such as, length of time in service, deployment, risk behavior by sexual partner type, alcohol use and uptake of HIV testing.

Methods

This was a cross-sectional study with data collection between October 2008 and November 2010. Consenting male, active-duty soldiers, who were aged $\geq$21 years (individuals aged $<$21 years are considered minors in Rwanda) in the RDF, regardless of HIV status if known at the time, were eligible to participate in the study. Female soldiers comprise less than 1 % of the overall military population in Rwanda; it was not possible to include women given resource and logistical limitations of this study. Additionally, because of the small numbers, it would have been difficult to report any useful data without compromising the confidentiality of the female participants. Study procedures included an anonymous 60 to 90 min self-administered questionnaire with subsequent HIV rapid testing conducted by trained counseling and testing staff. The results from this HIV test were anonymously linked to the questionnaire by a unique identification number.

Soldiers were recruited from 46 military sites throughout Rwanda, including sites located near neighboring country borders, Kigali, and other urban and rural areas. Military sites were selected from a full list of all military sites by Rwanda military collaborators (US investigators were not provided this list) to diversify region representativeness and exclude sites that were deployed or involved in off-site training exercises. One thousand four hundred and seventeen soldiers met the age criteria ($\geq$21 years) for eligibility to participate in the study; 56 soldiers did not provide consent for participation and 26 surveys did not have corresponding HIV test results, resulting in 1,335 participants who met the complete inclusion criteria for study eligibility. Of these, an additional 28 participants' data were excluded because of survey irregularities (e.g., blank, missing $\geq$3 pages). A final sample size of 1,307 soldiers data were available for analysis.

Using a self-administered paper questionnaire, participants were requested to provide information on basic demographics (e.g., age, marital status, education, religion, rank, occupation, deployment history); history of circumcision and who performed the procedure; presence of STI symptoms in the past 12 months (e.g., Have you had an abnormal discharge from your penis? and Have you had an ulcer or sore on or near your penis?); HIV testing history and predominant condom use during vaginal sex in the past 12 months. Standard knowledge and stigma questions derived from both the United Nations General Assembly Special Session on HIV/AIDS [11] and the Rwanda Demographic Health Survey [1] were included on the questionnaire.

The questionnaire also included characterizing specific partner types in the past 3 months: (1) regular partner, cohabitating, (2) regular partner, not cohabitating, (3) occasional partners that were not female sex workers and (4) female sex workers. If the participant indicated he had a specific sexual partner type, he was instructed to complete three subsequent follow-up questions for that partner type: (1) whether a condom was used at last sex, (2) whether they or their partner were drinking less than 2 h before sex and (3) their partner's HIV status. Partner specific questions were not mutually exclusive. For example, the same participant could mark that he had both a regular cohabitating partner and also sex with a female sex worker in the past 3 months, therefore, only descriptive statistics were calculated. Alcohol use information was collected using the self-administered form of the Alcohol Use Disorders Identification Test (AUDIT) [12].

HIV testing was conducted using a World Health Organization recommended serial testing algorithm [13] with three rapid tests in this order: (1) First Response HIV 1–2.0 (Premier Medical Corporation, Watchung, NJ, USA), (2) Uni-Gold HIV (Trinity Biotech, Bray, Co Wicklow, Ireland) and (3) Capillus HIV-1/HIV-2 (Trinity Biotech, Bray, Co Wicklow, Ireland). Participants were determined to be HIV negative if the first rapid test used showed a negative result or if the first two rapid tests were discordant and the third test was negative. If the first test was positive, a second confirmatory test was conducted and if positive, the participant was determined to be HIV positive. In 2009 (midway through data collection) the National HIV rapid testing algorithm guidelines changed and new rapid tests were utilized: (1) Alere Determine HIV-1/2 (Alere Medical Co., Ltd., Matsuhidai, Matsudo-shi, Chiba-ken, Japan), (2) SD Bioline (Standard Diagnostics Inc., Hagal-dong, Giheung-ku, Yongin-si, Kyonggi-do, Republic of Korea), and (3) Uni-Gold Recombigen HIV (Trinity Biotech, Bray, Co Wicklow, Ireland).

Human Subjects Protection and Ethical Considerations

This study protocol was approved by Human Subjects Protection Organizations both within the United States (San Diego State University, University of California, San Diego, and Naval Health Research Center) and Rwanda [Ministry of Defense, the National Commission for AIDS Control (CNLS), the Ethics Review Committee and Institut National de la Statistique du Rwanda (INSR)]. All study documents were translated from English into Kinyarwanda and back-translated into English prior to study protocol approval. Participation in this study was completely voluntary and no compensation was provided to soldiers who consented to participate. Substantial effort was made to ensure that soldiers felt the freedom to accept or decline participation in the study; early discussion with senior RDF leadership during study protocol development confirmed their support for the voluntary consent process. Also, in both verbal and written instruction, soldiers were provided with information on the voluntary consent process and encouraged to ask questions or address concerns about consent. Because the survey was anonymous, soldiers could leave the survey blank or not mark the consent form to indicate that they did not want to participate in the study, without anyone knowing they did not participate.

Data Analysis

Data were entered into an Epi-Info database and exported and analyzed using SAS software version 9.2 (SAS Institute, Inc., Cary, NC). Confidence intervals (95 %) surrounding the HIV point prevalence were calculated. For all aims, descriptive statistics were calculated for continuous variables and rates calculated for categorical variables. *T*-tests (for continuous variables) and Pearson Chi-square tests (for categorical variables) were used to assess whether there was a significant difference for each independent

variable by HIV status. For continuous variables, if the *F*-test for the equality of two variances was found to be statistically significant ($p \leq 0.05$) when doing bivariate analysis, the *p*-value calculated using the *T*-test (unequal variances version) was reported. If categorical variables had less than an expected count of five in any strata of the contingency table, the Fisher's exact test was used to calculate the *p* value. For unadjusted analysis the Pearson Chi-square *p* value was reported.

A standard cut-off score of ≥8 on the AUDIT was used to indicate harmful and hazardous alcohol use, a score of 1–7 to indicate low risk alcohol use, and 0 as no alcohol use. Participants with ≥2 missing responses on the AUDIT were only included if they had already met criteria for harmful and hazardous alcohol use (a score of ≥8); participants missing one response were included only if they could clearly be categorized based on the sum of their score and the number of missing responses. Internal consistency was relatively high with a Cronbach's alpha of 0.79.

Factors reported in the literature to be associated with HIV infection or HIV-related risk behavior [7, 14–18] or determined to have a *p*-value of ≤0.15 in bivariate analysis were considered during multivariable regression modeling using the Likelihood Ratio Test. To ensure that the final model was not over parameterized given the small number of participants with HIV, the final model only included variables that were: highly significant in the bivariate analysis ($p \leq 0.02$), reported in the literature as being associated with HIV infection [16–20] and met the Likelihood Ratio Test criteria ($p \leq 0.05$) for inclusion in the model. Measures of association (odds ratio, 95 % CI) were calculated using the proc logistic procedure in SAS. All *p*-values were based on two-tailed tests of significance, defined as $p \leq 0.05$. *P*-values were not adjusted for multiple comparisons.

Results

HIV Prevalence and Population Characteristics

Overall HIV prevalence was 2.6 % ($n = 34/1307$; 95 % CI: 1.84–3.66). Participants were, on average, 31 years old (30.9 ± 5.6; range 21–48 years), with over 96 % between 21 and 40 years of age (see Table 1). The majority were married or living with a partner (66.1 %) with nearly one-third never married (31.1 %) and few reporting that they were divorced, separated or widowed (2.7 %). Marital status was significantly associated with HIV infection ($p < 0.01$), with more HIV positive participants who were ever divorced, separated, or a widow (18.2 vs 2.3 %) than HIV negative participants. The majority (80.6 %) of participants served in the military for 6 or more years (mean 11.0 ± 5.3 years) with 92 % reporting assignment to the army branch (data not shown) and the majority reporting lower (soldier or corporal) rank (78.9 %). About half of the participants had completed their secondary education or more (53.8 %) with an average of 7 years of school completed (7.2 ± 2.3; range 0–15 years). Slightly less than half reported Catholic religious affiliation (45.6 %). Approximately 85 % of reporting participants ($n = 1{,}043/1{,}220$) had been tested for HIV in the previous 12 months and received their test results. The majority of HIV positive soldiers (64.3 %; $n = 18/28$) correctly reported they were HIV positive prior to being tested the day of the survey (data not shown).

Military-Specific Factors

Length of time in the military was significantly associated with HIV infection ($p = 0.02$) with more HIV positive participants reporting 6 or more years of service (94.1 vs 80.2 %) compared to HIV negative participants; participants who reported serving in the military for 9–18 years accounted for 91 % of all HIV infections. Almost all ($n = 32/34$) HIV positive participants reported being in the military prior to the 2004 policy change that denied entry to recruits who were HIV positive (data not shown). About half (50.9 %) of participants reported ever serving on a foreign deployment and significantly more HIV positive participants reported they never had been foreign deployed compared with those who had deployed (70.6 vs 48.5 %, $p = 0.01$). This likely reflects deployment eligibility based on HIV screening prior to deployment. More HIV positive participants were currently located near the Burundi border (23.5 vs 13.4 %), Uganda border (14.7 vs 6.2 %) or living in the Kigali (11.8 vs 5.8 %) or West province (47.1 vs 32.8 %) than HIV negative participants.

HIV Knowledge and Stigma

HIV knowledge among participants was high on most questions (including typically reported UNGASS questions), did not significantly differ by HIV status and was similar to levels reported among the general population in the 2005 DHS (data not shown). Likewise, very little stigma was observed, consistent with or maybe even lower than in the general population, with a few exceptions; 53 % of participants reported that if their family member were infected, they would want it to remain a secret, 5 % of participants reported that they knew someone denied participation in religious/community events in the past 12 months because of AIDS and 6 % knew someone who had been insulted, mistreated or abused in the past 12 months for the same reason. Stigma attitudes did not differ significantly by HIV status with the exception of one

Table 1 Demographics of RDF participants by HIV status

Characteristic	Total ($n = 1,307$) n (%)	HIV positive ($n = 34$) n (%)	HIV negative ($n = 1273$) n (%)	p-value
Age, years ($N = 1,307$)				0.16
21–24	192 (14.7)	0 (0.0)	192 (15.1)	
25–29	348 (26.6)	10 (29.4)	338 (26.6)	
30–34	408 (31.2)	13 (38.2)	395 (31.0)	
35–39	265 (20.3)	9 (26.5)	256 (20.1)	
40–48	94 (7.2)	2 (5.9)	92 (7.2)	
mean $\pm$ SD	30.9 $\pm$ 5.6	32.4 $\pm$ 4.7	30.9 $\pm$ 5.6	0.13
(range)	(21–48)	(25–46)	(21–48)	
Marital status ($N = 1,278$)				<0.01
Single	398 (31.1)	2 (6.1)	396 (31.8)	
Married or living with partner	845 (66.1)	25 (75.8)	820 (65.9)	
Divorced, widowed, or separated	35 (2.7)	6 (18.2)	29 (2.3)	
Education level ($N = 1,288$)				0.42
Primary or less	595 (46.2)	18 (52.9)	577 (46.0)	
Secondary or more	693 (53.8)	16 (47.1)	677 (54.0)	
Religious affiliation ($N = 1,276$)				0.64
Evangelical/Pentecostal	116 (9.1)	1 (2.9)	115 (9.3)	
Protestant	291 (22.8)	10 (29.4)	281 (22.6)	
Adventist	231 (18.1)	5 (14.7)	226 (18.2)	
Muslim	56 (4.4)	2 (5.9)	54 (4.3)	
Catholic	582 (45.6)	16 (47.1)	566 (45.6)	
Military rank ($N = 1,278$)				0.12
Soldier	616 (48.2)	12 (35.3)	604 (48.6)	
Corporal	392 (30.7)	13 (38.2)	379 (30.5)	
Sergeant	73 (5.7)	4 (11.8)	69 (5.5)	
Staff Sergeant	100 (7.8)	3 (8.8)	97 (7.8)	
Sergeant Major	32 (2.5)	2 (5.9)	30 (2.4)	
2nd Lieutenant (LT), LT, Captain	65 (5.1)	0 (0.0)	65 (5.2)	
Years in the military ($N = 1,275$)				0.02
0–5 years	248 (19.5)	2 (5.9)	246 (19.8)	
6 + years	1,027 (80.6)	32 (94.1)	995 (80.2)	
Occupation ($N = 1,264$)				0.56
Soldier	948 (75.0)	28 (82.4)	920 (74.8)	
Logistics Officer	40 (3.2)	1 (2.9)	39 (3.2)	
Educator/instructor	85 (6.7)	1 (2.9)	84 (6.8)	
Clerk, driver, technician	29 (2.3)	0 (0.0)	29 (2.4)	
Health provider, lawyer, engineer	70 (5.5)	0 (0.0)	70 (5.7)	
Other	92 (7.3)	4 (11.8)	88 (7.2)	
Foreign deployment ($N = 1,211$)				0.01
Never deployed	595 (49.1)	24 (70.6)	571 (48.5)	
Ever deployed	616 (50.9)	10 (29.4)	606 (51.5)	
Province ($N = 1,307$)				
West	434 (33.2)	16 (47.1)	418 (32.8)	0.16
North	265 (20.3)	6 (17.7)	259 (20.4)	
East	218 (16.7)	3 (8.8)	215 (16.9)	
South	312 (23.9)	5 (14.7)	307 (24.1)	
Kigali	78 (5.9)	4 (11.8)	74 (5.8)	

Table 1 continued

Characteristic	Total ($n = 1,307$) n (%)	HIV positive ($n = 34$) n (%)	HIV negative ($n = 1273$) n (%)	p-value
Region ($N = 1,307$)				
Kigali	78 (5.9)	4 (11.8)	74 (5.8)	0.06
Other urban	181 (13.9)	1 (2.9)	180 (14.1)	
Rural	1,048 (80.2)	29 (85.3)	1,019 (80.1)	
Border location ($N = 1,307$)				
DRC border	313 (24.0)	8 (23.5)	305 (24.0)	0.04
Burundi border	179 (13.7)	8 (23.5)	171 (13.4)	
Uganda border	84 (6.4)	5 (14.7)	79 (6.2)	
Not near a border	731 (55.9)	13 (38.2)	718 (56.4)	
Prior to today, previous HIV test ($N = 1,220$)				
Yes	1,125 (92.2)	33 (100.0)	1,092 (92.0)	0.10
No	95 (7.8)	0 (0.0)	95 (8.0)	
Previously tested and received results ($N = 1,125$)				
Yes	1,043 (92.7)	28 (84.8)	1,015 (92.9)	0.11
No	29 (2.6)	2 (6.1)	27 (2.5)	
Not reported	53 (4.7)	3 (9.1)	50 (4.6)	

SD standard deviation, *DRC* Democratic Republic of the Congo

question that asked whether people who have AIDS are responsible for bringing the disease into the community ($p = 0.02$); HIV positive participants were less likely to support this statement.

Partner-Specific HIV Risk

As shown in Table 2, 14.2 % of participants reported having sex with a female sex worker (FSW) in the past 3 months and 23.8 % reported an occasional sex partner (who was not an FSW). Condom use at last sex was highest (76 %) among participants who reported sex with an FSW. Alcohol use by both partners, 2 h before sex, was more commonly reported by participants who had sex with an FSW (28.1 %) and those with a regular, non-cohabitating sex partner (19.9 %). Eighty-nine participants reported both an occasional and FSW partner (6.8 %) in the past 3 months, 46 reported all four partner types (3.5 %), 156 reported a regular, cohabitating sex partner and either an occasional or FSW partner (11.9 %), and 150 reported a non-cohabitating regular partner and either an occasional or FSW partner (11.5 %; data not shown). For three of the four partner types (regular, non-cohabitating, occasional and FSW), drinking before sex was determined to be significantly (or borderline) associated with HIV infection (data not shown).

Nearly all ($n = 30/34$) of the HIV positive participants were either married, living with a woman or having sex with a specific partner type in the past 3 months. Of those who reported their sex partner's HIV status, the majority ($n = 11/16$) reported their partners' status as negative or unknown.

Sexual Risk Behavior

As shown in Table 3, over 80 % of participants were ≥18 years when they first had sexual intercourse with a woman. The majority of participants (68.3 %) who reported vaginal intercourse (past 12 months) used condoms sometimes, rarely or never. Nearly one-third of participants with regular partners (married, or living together) reported outside occasional sexual partners. Participants with HIV were significantly more likely to report sex with an FSW in the past 3 months (27.3 vs 13.8 %, $p = 0.04$) than HIV negative participants. HIV infection was significantly associated ($p < 0.01$) with the total number of lifetime partners with 71 % of HIV positive participants reporting 6 or more partners compared to only 40.3 % of HIV negative participants. Likewise, threefold more (34.4 vs 11.4 %) HIV positive participants reported STI symptoms than HIV negative participants ($p < 0.01$).

Safer Sex Behavior Among HIV Positive Participants

The frequency of vaginal condom use in the past 12 months was reported as "most times" or "always" by a higher percentage of HIV positive personnel: 46 % ($n = 6/13$) among soldiers who knew they were HIV positive and

Table 2 Behavior by sexual partner type among RDF participants

Characteristic	Regular[a] Live with ($n = 1132$) n (%)	Regular[b] Do not live with ($n = 1,207$) n (%)	Occasional[c] Not FSW ($n = 1,089$) n (%)	FSW[d] ($n = 1,179$) n (%)
Reported partner type[e]				
Yes	262 (23.1)	198 (16.4)	259 (23.8)	167 (14.2)
No	870 (76.9)	1,009 (83.6)	830 (76.2)	1,012 (85.8)
If yes, at last sex:				
Condom used				
Yes	130 (55.3)	106 (61.3)	147 (63.1)	114 (76.0)
No	105 (44.7)	67 (38.7)	86 (36.9)	36 (24.0)
Alcohol use 2 h before sex				
Participant was drinking	44 (19.8)	29 (18.6)	27 (12.2)	21 (15.1)
Participants partner was drinking	2 (0.9)	6 (3.8)	8 (3.6)	5 (3.6)
Both were drinking	34 (15.3)	31 (19.9)	36 (16.3)	39 (28.1)
No	142 (64.0)	90 (57.7)	150 (67.9)	74 (53.2)
Partner's HIV status				
HIV positive	13 (5.9)	11 (6.8)	8 (3.8)	11 (8.0)
HIV negative	111 (50.0)	37 (22.8)	78 (36.8)	20 (14.5)
Don't know	98 (44.1)	114 (70.4)	126 (59.4)	107 (77.5)
Material item provided to partner				
Yes			74 (32.6)	
No			153 (67.4)	

FSW, female sex worker

[a] In the past 3 months, have you had any regular sexual partners with whom you live?

[b] In the past 3 months, have you had any regular sexual partners with whom you do not live?

[c] In the past 3 months, have you had any occasional sexual partners who were not prostitutes or female sex workers?

[d] In the past 3 months, have you had sex with any prostitutes or female sex workers?

[e] Participants could mark more than one sexual partner type, so categories were not mutually exclusive. Data were reported only for participants who provided a response to the specific partner type question

38 % ($n = 3/8$) among soldiers who were positive, but reported they were negative versus 31.5 % in HIV negative personnel (data not shown). Although the numbers were very small and no statistically significant difference was identified ($p = 0.36$), when comparing HIV positive personnel who knew they were positive to HIV positive personnel who did not know they were HIV positive, more ($n = 4/17$, 23.5 %) HIV positive participants who correctly reported they were HIV positive, reported no sex partners in the past 12 months than the 11.1 % ($n = 1/9$) of HIV positive participants who reported they were HIV negative prior to being tested that day.

Circumcision

Significantly more HIV positive participants were uncircumcised (65.6 vs 44.7 %) than HIV negative participants ($p = 0.02$). HIV prevalence was higher among those whose procedure was performed by a traditional circumciser (3.1 %, $n = 1/32$) than among those performed by a medical provider (1.6 %, $n = 10/633$), but this finding was not statistically significant ($p = 0.42$; data not shown).

Alcohol Use

HIV positive participants screened positive for harmful and hazardous alcohol use significantly more often than HIV negative participants (20.7 vs 9.9 %, $p = 0.02$), however, harmful and hazardous alcohol use in the RDF was determined to be quite low overall (10.2 %) compared with other militaries [15, 21].

Multivariable-Adjusted Analyses

As shown in Table 4, after adjusting for marital status, STI symptoms and circumcision, participants who reported they were ever divorced, widowed or separated had higher

Table 3 Sexual risk behavior and alcohol use among RDF participants by HIV status

Characteristic	Total (n = 1,307) n (%)	HIV positive (n = 34) n (%)	HIV negative (n = 1,273) n (%)	p-value
Age at first sex, years (N = 1,139)				0.53
<15	43 (3.8)	2 (6.3)	41 (3.7)	
15–17	155 (13.6)	6 (18.8)	149 (13.5)	
18–20	497 (43.6)	13 (40.6)	484 (43.7)	
21–24	245 (21.5)	4 (12.5)	241 (21.8)	
25–30	187 (16.4)	7 (21.9)	180 (16.3)	
31–40	12 (1.1)	0 (0.0)	12 (1.1)	
Mean ± SD	20.5 ± 4.2	20.2 ± 4.2	20.5 ± 4.2	0.68
(range) median	(1–40) 20	(14–30) 20	(1–40) 20	
Total sex partners, past 12 months (N = 1,234)				0.42
0	317 (25.7)	7 (21.2)	310 (25.8)	
1	644 (52.2)	16 (48.5)	628 (52.3)	
2–5	248 (20.1)	10 (30.3)	238 (19.8)	
≥6	25 (2.0)	0 (0.0)	25 (2.1)	
Mean ± SD	1.2 ± 1.4	1.5 ± 1.4	1.2 ± 1.4	0.30
(range) median	(0–10) 1	(0–5) 1	(0–10) 1	
Total lifetime sex partners (N = 1,186)				
0	100 (8.4)	0 (0.0)	100 (8.7)	<0.01
1	170 (14.3)	5 (16.1)	165 (14.3)	
2–5	428 (36.1)	4 (12.9)	424 (36.7)	
≥6	488 (41.2)	22 (71.0)	466 (40.3)	
Mean ± SD	15.3 ± 51.5	28.8 ± 50.6	15.0 ± 51.5	0.14
(range) median	(0–711) 4	(1–205) 10	(0–711) 4	
Outside sexual partners[a] (N = 705)				
Regular partners only	145 (20.6)	4 (16.6)	141 (20.7)	0.86
Occasional partners only	207 (29.4)	7 (29.2)	200 (29.4)	
Regular and occasional partners	32 (4.5)	1 (4.2)	31 (4.6)	
No outside partners	321 (45.5)	12 (50.0)	309 (45.3)	
Sex with an FSW, past 3 months (N = 1,179)				
Yes	167 (14.2)	9 (27.3)	158 (13.8)	0.04
No	1,012 (85.8)	24 (72.7)	988 (86.2)	
Vaginal condom use, past 12 months[b] (N = 891)				
Never	321 (36.0)	8 (29.6)	313 (36.2)	0.61
Rarely	102 (11.4)	2 (7.4)	100 (11.6)	
Sometimes	186 (20.9)	7 (25.9)	179 (20.7)	
Most times	96 (10.8)	5 (18.5)	91 (10.5)	
Always	186 (20.9)	5 (18.5)	181 (21.0)	
Abnormal discharge from penis, past 12 months (N = 1,237)				
Yes	79 (6.4)	9 (28.1)	70 (5.8)	<0.01
No	1,158 (93.6)	23 (71.9)	1,135 (94.2)	
Ulcer or sore on/near penis, past 12 months (N = 1,218)				
Yes	107 (8.8)	8 (25.0)	99 (8.4)	<0.01
No	1,111 (91.2)	24 (75.0)	1,087 (91.6)	
Any STI symptom, past 12 months (N = 1,265)				
Yes	151 (11.9)	11 (34.4)	140 (11.4)	<0.01
No	1,114 (88.1)	21 (65.6)	1,093 (88.6)	

Table 3 continued

Characteristic	Total (n = 1,307) n (%)	HIV positive (n = 34) n (%)	HIV negative (n = 1,273) n (%)	p-value
Self-reported circumcision (N = 1,252)				
Yes	686 (54.8)	11 (34.4)	675 (55.3)	0.02
No	566 (45.2)	21 (65.6)	545 (44.7)	
Alcohol use (AUDIT score), (N = 1,187)				
No alcohol use	565 (47.6)	7 (24.1)	558 (48.2)	0.02
<8 (low risk alcohol use)	501 (42.2)	16 (55.2)	485 (41.9)	
≥8 (harmful and hazardous alcohol use)	121 (10.2)	6 (20.7)	115 (9.9)	
Mean ± SD	2.3 ± 3.8	4.2 ± 4.3	2.3 ± 3.7	<0.01
(range) median	(0–22) 1	(0–15) 3	(0–22) 1	

SD standard deviation, *FSW* female sex worker, *STI* sexually transmitted infection, *AUDIT* Alcohol Use Disorders Identification Test

[a] Selected only on participants classified as married or living with a partner as if married

[b] Selected only on participants who reported a sexual partner in the past 12 months

Table 4 Adjusted odds ratios for factors associated with HIV among RDF participants

Characteristic	Final model (N = 1,199)	
	OR[a] (95 % CI)	p-value
Marital status		<0.01
Single	1.0	
Married or living with partner	4.4 (1.0–19.2)	
Divorced, widowed, or separated	29.8 (5.5–159.9)	
Any STI symptom		<0.01
Yes	3.4 (1.5–7.6)	
No	1.0	
Self-reported circumcision		0.04
Yes	0.4 (0.2–0.9)	
No	1.0	

OR odds ratio, *CI* confidence interval, *STI* sexually transmitted infection

[a] Odds ratio adjusted for marital status, STI symptoms, and circumcision

odds of HIV infection than those who were single (OR = 29.8; 95 % CI: 5.5–159.9) and participants who reported STI symptoms in the past 12 months had higher odds of HIV infection than those who did not report any symptoms (OR = 3.4; 95 % CI: 1.5–7.6). Circumcision was found to be protective (OR = 0.4; 95 % CI 0.2–0.9) against HIV infection. We also compared participants who were HIV infected, with participants who were HIV negative but reported STI symptoms (data not shown). Interestingly, significantly more HIV negative participants with STI symptoms were circumcised than HIV positive participants (55 vs 34 %, p = 0.03), indicating a possible protective effect for HIV only.

Discussion

The HIV prevalence among RDF military participants was similar to rates reported among males in the general population of Rwanda (2.6 vs 2.3 %) [1]. Factors significantly associated with HIV infection were: being divorced, widowed, or separated, reporting STI symptoms and being uncircumcised, after adjusting for each other. These findings suggest a concentrated HIV epidemic in the RDF, with the majority reporting safer sex behaviors (e.g, 26 % had no sexual partners in the past year, 55 % were circumcised, 48 % did not drink any alcohol), and few engaged in high risk behaviors or reported STI symptoms (11.9 %). An exception to this was low overall condom use which may reflect that soldiers in regular partnerships do not consider themselves at risk for infection; this exposes a vulnerable gap in behavior that could quickly escalate HIV infection given the right circumstances. Nonetheless, overall HIV prevalence was low, and the majority of both HIV negative and HIV positive soldiers (who knew their status) reported safer sex behaviors; these findings are encouraging and suggest that the combination prevention and Prevention with Positives (PWP) programs conducted among RDF are effective, although additional research is needed.

Militaries are motivated to support combination HIV prevention activities given the large expense associated with treating HIV positive soldiers, and the potential loss in productivity, force readiness, and sustainability of established commands [4, 22]. The RDF leadership has been highly progressive in their promotion of male circumcision, routine HIV testing and counseling and treatment provision for patients (≤350 CD4 cell count), safer sex messaging and access to free condoms on and near all military bases. Although it is impossible to determine when soldiers were

infected, incident infection may be quite low. Over 90 % of the HIV positive RDF participants were recruited prior to the updated testing policy that denies entry to HIV positive recruits, and it is unknown how many participants may have already been infected with HIV when they joined the military.

Several observations from this study suggest that combination prevention, heavily supported by RDF leadership, has played a key role in the low HIV prevalence observed, and conservative sexual behavior reported among military personnel. For example, fourfold more soldiers reported being circumcised (55 vs 12.3 %) than men of comparable age in the Rwandan general population [23], likely resulting from the military-integrated medical care system promoting voluntary medical male circumcision that makes it easier for soldiers to be circumcised. The observed protective effect of circumcision (adjusted odds ratio = 0.4) against HIV infection in the RDF is consistent with findings from widely accepted randomized control trials that show circumcision reduces the risk of HIV infection [19, 20]. Additionally, the level of previous HIV testing in the RDF (85 %) was more than threefold higher than levels reported in the Rwandan general population and most of sub-Saharan African [1, 24]. Furthermore, over half of the HIV positive participants already knew they were HIV positive prior to getting tested the day of the survey, which is remarkable considering very few people infected with HIV in the general population are aware they are HIV positive [24]. This is encouraging given that individuals who know they are HIV positive are more likely to change their behavior in ways that reduce HIV transmission (e.g, condom use, reduction in sexual partners, treatment) and demonstrates the impact leadership support for routine, frequent HIV testing can have. Most soldiers had one or no sexual partner in the past 12 months (78 %) and almost half reported no alcohol use (only 10 % screened positive for harmful and hazardous alcohol use). This is much lower relative to rates reported in other militaries [21, 25] and may reflect uptake of HIV prevention, including alcohol reduction, messaging aimed to reduce risk behavior. Likewise, although numbers were small, HIV positive soldiers reported using condoms more frequently than HIV negative soldiers, suggesting that the RDF's PWP program, initiated in 2006, may have had a positive impact. More frequent condom use among HIV positive individuals was also observed in the Rwandan general population and is thought to demonstrate HIV positive individuals trying to protect their partners [1].

Sentinel Risk Behavior

These data suggest that the HIV epidemic within the RDF is concentrated, and results from risky sexual behavior among a core group of individuals. A small, but substantial number of participants reported STI symptoms, more than one sex partner, sex with higher risk partner types (e.g, occasional or FSW) or both a regular partner and occasional or FSW. Likewise, alcohol use before sex was highest among those reporting sex with FSWs, showing that some individuals are combining high risk behaviors with high risk partners. While these behaviors are comparable in other military populations [15, 26, 27], efforts to more frequently screen and treat STIs, promote condom use and discourage sexual contact with sex workers and alcohol use before sex should be incorporated as part of an intervention effort to reduce HIV transmission. A reduction in concurrent sexual partnerships will also likely protect regular partners (that report the lowest condom use rates) who may be at increased risk for infection.

Soldiers Living with HIV

HIV positive participants were found to report significantly higher levels of harmful and hazardous alcohol use than HIV negative participants (21 vs 10 %), in unadjusted analysis. Alcohol use can have a detrimental effect on treatment adherence, and progression of HIV [28–30] and should be addressed among HIV positive RDF.

Nearly all ($n = 30/34$) of the HIV positive RDF personnel were in partnerships (e.g, married, living with a woman, or had sex in the past 3 months). Earlier initiation of ART within discordant partnerships among RDF should be considered if funding and resources are available given HPTN 052 study results recently showed that HIV transmission within a heterosexual, sero-discordant partnership is essentially eliminated (96 % reduction) when the HIV positive partner is provided with anti-retroviral therapy at an earlier stage of infection (CD4 count of 350–550) [31].

Limitations

The findings cannot be generalized to the military as a whole given the sampling methodology, however participants were recruited from a large number ($n = 46$) of military sites across Rwanda to include urban, rural, and border sites, and selected to maximize multi-region representativeness. Fifty-six participants did not provide consent to participate, but over half of the HIV positive participants knew they were positive, so non-participation is not likely related to HIV infection. HIV is a relatively rare event in this population so the small number of individuals with this outcome ($n = 34$) may have limited visibility into smaller magnitude associations with HIV infection after adjustment of other variables, because of the lack of power. Also, it is unknown when participants were infected with HIV, making the temporality of infection related risk behavior more difficult to discern. However, reported proportions

and significant univariate and multivariate associations are consistent with findings reported in other study populations [1, 15, 16, 19, 25].

Conclusion

HIV prevalence in the RDF was similar to the general population despite being deployed away from loved ones for long periods of time, peer pressure and other factors typical in military settings that create unique circumstances for HIV infection. This likely results from effective policies, leadership support of HIV combination prevention and conservative sexual behavior among most RDF personnel. Significant factors associated with HIV infection (in adjusted analyses) were being divorced, widowed or separated, reporting STI symptoms and being uncircumcised. Targets for intervention include increasing condom use and access to voluntary medical male circumcision for all soldiers, and reducing multiple concurrent partnerships, sex with sex workers and STIs in a small, but substantial group of soldiers who engage in high risk behavior. Targeting HIV negative soldiers early in their military career may prevent a substantial proportion of new HIV infection within the military. A high frequency of HIV positive personnel in partnerships suggests that early treatment with ART, if resources are available, could reduce HIV transmission within discordant partnerships. Directing HIV prevention resources towards these activities may reduce military HIV prevalence, prevent further transmission to partners, and protect HIV negative soldiers from becoming infected.

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14. ABSTRACT

A cross-sectional study was conducted among active-duty male soldiers, > 21 years old, in the Rwanda Defense Forces (RDF) and included an anonymous behavioral survey and HIV rapid testing to determine risk factors associated with HIV seroprevalence. Overall prevalence was 2.6% (95% CI 1.84 – 3.66); personnel who were higher ranking, served >6 years, never deployed, divorced, separated or widowed, uncircumcised, reported STI symptoms, had >6 lifetime sex partners, or screened positive for a drinking problem (via Alcohol Use Disorders Identification Test) had higher HIV prevalence. Ever being divorced/separated/widowed (OR 29.8, 95%CI 5.5 – 159.9), and STI symptoms (OR 3.4, 95%CI 1.5 – 7.6) were significantly associated with infection after multivariable adjustment while circumcision was protective (OR 0.4, 95% CI 0.2 – 0.9). Despite mobility and other factors that uniquely influence HIV transmission in militaries, RDF prevalence was similar to the general population. A reason for this finding may be conservative sexual behavior combined with effective leadership-supported prevention programs. Data suggest a concentrated rather than generalized epidemic with targets identified for intervention.

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